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1956/57

CENTRAL ROAD RESEARCH INSTITUTE
NEW DELHI, INDIA

ANNUAL REPORT (1956-57)

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COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

CENTRAL ROAD RESEARCH INSTITUTE
NEW DELHI (INDIA).

ANNUAL REPORT FOR THE YEAR 1956-57.

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INTRODUCTION

There was an increase in the general pattern of research work during the year 1956-57 which was organised under the following five research divisions:- Soils; Flexible Pavements (bituminous materials), Rigid Pavements (mineral materials), Roads, and Traffic Engineering and Economic Research. The first four divisions deal with the materials and methods of construction while the last one deals with the questions relating to the statistical study of road traffic and safety. Besides, there are eight ancillary sections at the moments:- (1) Information, Library and Museum (2) Workshop (3) Administration (4) Accounts (5) Purchase and Stores (6) Civil (7) Drawing and Photography and (8) Horticulture.

In common with the other research organisations in the country, the Central Road Research Institute has been faced, of late, with the progressively growing demand for advice on the diverse problems of road design, construction and maintenance. During the year under review, the activities of this Institute markedly increased. Several new problems were undertaken for research and advice on related matters were given to major projects. Besides, the Institute continued to advise the Public Works Departments of different States, the C.P.W.D. and E-in-C's Branch on related matters as those of investigations on and construction of roads and airfields.

A beginning was made for rapid evaluation of road behaviour under stimulated traffic and weather conditions using the various specifications which were found successful at the Laboratory stage by trying them on inexpensive test tracks, semifield in nature. The results were encouraging. The specifications which were found to be successful in semifield experiments are being planned to be tested under actual traffic conditions in the various regions of the country. Despite many difficulties regarding shortage of building accommodation, equipment and research staff the Institute made progress in many fields as shown in the following pages:-

1. RESEARCH WORK DONE AT THE INSTITUTE

1.1. SOILS DIVISION.

1.1.1. Stabilised Soil Road Construction (Pilot Plant Scheme).

The use of stabilised soil in road construction by Mehra's method has already been tried on a full scale in the Punjab. There are as many as 250 miles of such roads which have stood the test of time. The cost of such a road with bituminous treatment is approximately half that of a conventional type of water-bound macadam road for the same service value. With the object of extending this system to other parts of India so that it can play its legitimate role in cutting down the cost of construction during the second five-year plan, small lengths of roads have been proposed to be constructed in areas of different climatic conditions, where binding of locally available soils is possible. In this connection a preliminary survey of soils has already been completed in the following states:

1. Madhya Pradesh, at Gwalior, Bhind and Rewa.
2. Rajasthan, at Ganganagar.
3. Orissa, at Bhubaneshwar.
4. Assam, at Guhati.
5. Pepsu, at Patiala and Bhadsan.
6. West Bengal at Howrah.

Plans are also underway to lay about one mile length each of experimental roads in other states as well.



A stabilised soil crust removed from a road after service of 11 years.

The above method of soil stabilisation is suitable only for areas where blending of locally available soils is possible. There are however large tracts of highly clayey black cotton soil where sand as an admixture is not readily available; road material has to be carried from long distances and on account of the very low bearing capacity of the subgrade in the wet condition, the thickness has to be of the order of about 20 inches. Research work has been carried out with the three different classes of black cotton soils (vide Road Research Note No.6) using various chemicals and it has been shown that comparatively small percentages of lime not only bring down the activity of the clay within acceptable limits and give requisite bearing power to the treated soils in the wet state, but also make the soil friable so that it can be easily pulverised. The last phenomenon is of great interest as the pulverization of highly clayey soils for stabilization purposes has presented very serious difficulties. The concentration of lime in making the soil non-plastic varies from 5-10% by weight, depending on the clayeyness of the soil. The soil thus treated improves considerably in CBR value and can therefore be used as sub-base. This may result in considerable saving by replacing a part of road pavement thickness which is otherwise built from more expensive material.

The concentration of the lime determined in the laboratory cannot be straightway recommended for large scale construction in view of the fact that it is not easy to obtain an intimate mixture of lime and soil in the field. To study the actual working of the process in the field, small scale trials are being carried out in areas where all the three types of black cotton soil exist. The places selected are; (1) Bhopal, (2) Bidar, (3) Medak. The last two places are in Andhra. The mixing in the field will be tried both manually and by light machinery to compare the comparative efficiency of the two methods.

1.1.3. Stabilization of moorum in Black Cotton Soil areas.

It has been mentioned before that sand or stone is not readily available in black cotton soil areas. But there are some deposits of moorums the coarse aggregate of which is not as strong as stone and the materials as such can also not be used because of soil fine which being too clayey in nature which makes the moorum lose its stability in the wet state. Research work in the laboratory has shown that the addition of 5% lime on the basis of soil mortar, increases the CBR of the moorum sufficiently to justify its use in road surfacing. Field trials are being taken up at Bhopal shortly.

1.1.4. Study of soft aggregates from different parts of India.

There are large deposits of soft aggregates such as moorum, laterite, kankar, etc., which exist in different states. These aggregates have so far been considered as unsuitable for use in road construction either due to their crushing strength being lower than that of stone or their being mixed up with clayey soil. Samples of all types of moorum which exist in different states were obtained through the respective Chief Engineers. 210 samples were received and are being subjected to various tests to find out their aggregate impact value and nature of soil fines, besides general grading.

The study for such materials from the 55 quarries in Rajasthan has been completed. This has shown that (i) some of these so called soft aggregates are fairly strong and compare well with Delhi quartzite. (ii) There are also materials which are well graded from the coarse to the fine fraction and form an ideal soil-gravel mixture.



Kankar from mile 3/1 of Jodhpur Road.



Kankar with fines from Avadu Road quarry in Sirohi (Rajasthan).



Moorum from Bhilwara sub-Division, Bhilwara (Ajmer).



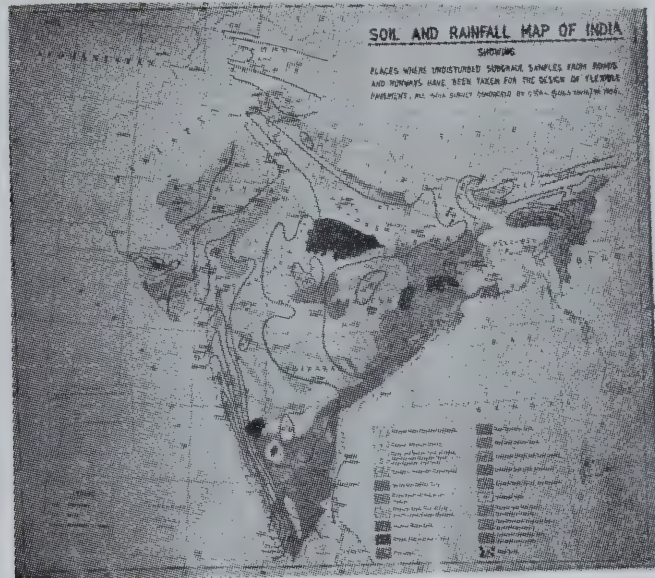
Moorum from Rajgarh section churi
sub-division, Bikaner.

(iii) There are others which contain small quantities of aggregate but the soil-fine is clayey, which again, is of interest because of its possibility of being blended with sand which is available at site. Such materials can be readily stabilized by Mehra's method. The study has divided the rank of aggregates in Rajasthan into four classes and methods to stabilise them economically have been suggested.

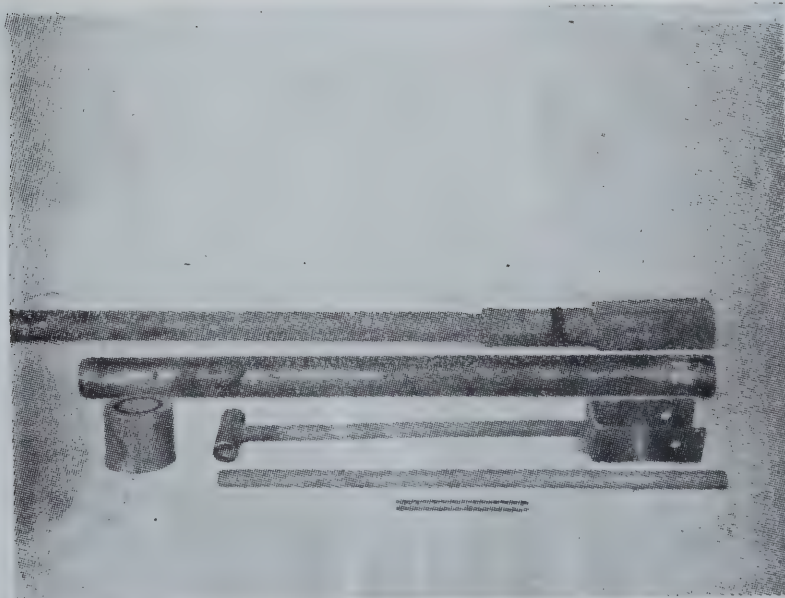
1.1.5. Study of subgrade moisture in
different parts of India for
purposes of pavement design.

There are several methods which have been developed in the past for designing the thickness of flexible pavements. According to the standard procedure the test is done on a saturated sample i.e. under the worst imaginable conditions. The design thickness thus determined will be economically justified only if the subgrade is likely to be saturated which is not always the case. It is, therefore, extremely important for purposes of economical design of road pavement to know the highest moisture attainable by the subgrade during the year, so that subgrade strength is determined at that moisture, not at saturation. The strength at saturation invariably becomes disproportionally low compared to strength at other moistures.

With this object in view, an All-India survey was carried out in areas of different soil types and climatic conditions. In the absence of a soil engineering map of India, the soil classification suggested by the Indian Agricultural Research Institute was made use of.



Division of India in different Zones on the basis of soil type and rainfall.



Equipment used in all India survey for subgrade moisture study.



Undisturbed subgrade soil sample being taken at one of the site.

The wetting of sub-grade greatly depends upon the rainfall intensity. According to the classification of the Meteorological Department, the country was divided into rainfall belts. The zoning of India was consequently done on the basis of 14 soil types and 8 rainfall belts. This gives 35 zones which take care of every type of soil with increasing rainfall intensities, in which observations were taken.

Since the problem of subgrade moisture is equally important for airfield pavement design, the survey was also extended to these, in collaboration with the Directorate of Civil Aviation

Worst subgrade moisture conditions occur when the water table is highest and this happens when the monsoon is withdrawing. The subgrade sampling was therefore organised in all the 35 zones at the time of the withdrawal of the monsoon. The undisturbed samples of the subgrade were taken both from the covered and uncovered lengths of road and runway for a depth of 3 feet.

There are, in all, about 600 samples which have been collected in the present survey. In addition to the undisturbed samples, about 1 cwt. weight of loose samples have also been collected from each site of investigation. The actual analytical work is in progress. The study is expected to give the following information:

(a) The variation in moisture distribution in the subgrade, and the effect on it of scaling the subgrade with a waterproof pavement.

(b) To what extent a further rise in the water table will effect this moisture distribution.

The latter result is expected to be obtained from PF moisture studies on the samples obtained. The above information is expected to give a clear picture of the worst possible moisture conditions for pavement design.

1.1.6. Stabilisation of soils with cement.

The engineering requirements of cement a soil mixture depends upon the use to which it is to be put. According to the A.S.T.M. the durability of the mixture is determined by the wetting and drying and freezing and thawing tests, so that at the end of 12 cycles the loss is not more than 3 percent. The durability test has been simplified in the U.K. It consists in determining the compressive strength of a cement soil cylindrical mould 4" high and 2" diam. at the end of 7 days' curing. If a strength of 250 lbs. is attained, the concentration is considered to be suitable for use in road bases, without recourse to the durability tests.

To find out how far the American or the British tests can be adopted to determine the durability of Indian Soils, a study was conducted with a few soils, a chemical characteristics. These were compacted to different densities with increasing percentages of cement and subjected to all the tests mentioned above. The study with the sandy and silty soils is completed and is being extended to clayey soils. When the study is complete, it will be possible to classify durability tests for; (i) tropical areas and for (ii) areas subject to frost action.

1.1.7. A new method of determining Liquid Limit of soils.

The mechanical device for determining liquid limit of soils has certain drawbacks. On account of the fact that sandy soils have high permeability, free water appears on the metallic bowl resulting in wrong values of liquid limit. As a result of testing a large number of soils, it has been noticed that sandy soils below 10 P.I. give a low figure for liquid limit and the error increases as the P.I. of the sample falls.

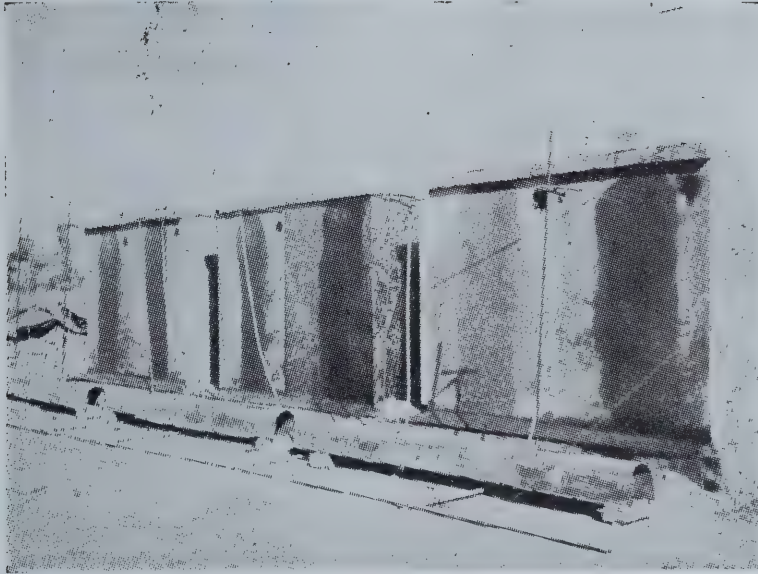
After a number of trials a method has been evolved which consists of a cone with half angle of 15'-30'. The Liquid limit of the soil is attained when the cone under a load of 150 gm. can penetrate to a depth of 1 inch. The method is being presented for standardization.

1.1.8. Foundation-engineering study of Delhi Sub-soil.

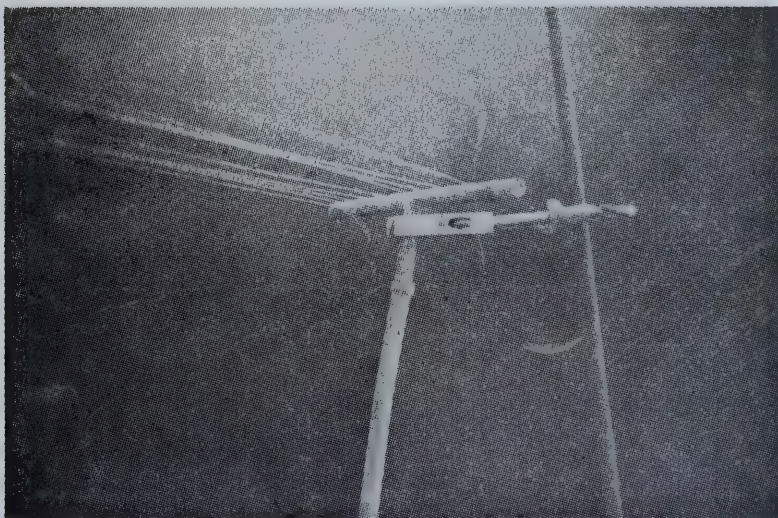
The sub-soil water table at Delhi has been rising for some years and at present in places it is almost 4'-5' from the surface. This has caused apprehensions that the bearing capacity of the soil may be considerably lowered. There was a proposal to lower the water table but this might also affect the stability of the existing buildings. The problem has now been referred to the Central Road Research Institute for investigations. Undisturbed soil samples from various places in affected areas have been taken to a depth of about 40' and these are being subjected to various tests in the Laboratory. The object is to investigate the effect of lowering of water table on differential settlement that the structures might undergo due to erratic pumping and non-uniform sub-soil conditions. The work is in progress.

1.1.9. Comparative tests of water-proof rendering of mud walls.

At the request of the National Buildings organisation, the problem was undertaken to test the various specifications which have been claimed by various organisations in the country, for water-proofing of mud walls under identical conditions, so that the best plaster amongst these could be recommended for trial in the community developments schemes. There are as many as 16 specifications which were subjected to rain effect continuously for six days and those which survived the test were further subjected to wetting during night and drying during day for 50-75 cycles. The work has been detailed in a report submitted to the National Buildings Organisation.



A close view of the various specifications under test.



A spraying jet.



Ordinary country mud plaster.
Conditions after 4 hours spraying.



Condition after 11 hours spraying. Blackmarks
on the left show places where samples were
taken for determining moisture content.

. 1.2. BITUMINOUS MATERIALS DIVISION.

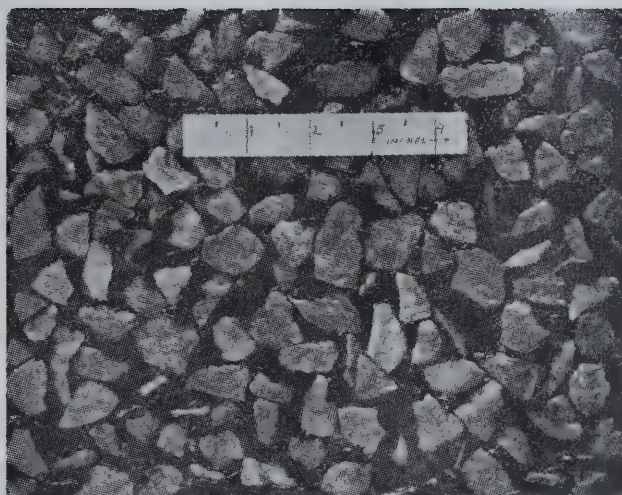
One of the earliest investigations that was undertaken in the bitumen division was to study the effect of impregnation of brick metal with a bituminous binder. The problem was confined to the laboratory only and the results showed that the strength of bricks could be considerably increased by the process. Another problem that was tackled was to evolve a cheap hot pour-type of jointing compound and a patent was filed on the same. Some attempts were also made to evolve a simple method of making bitumen emulsions using various emulsifying agents. A laboratory analysis of Tar-bitumen mixtures was also done, using surface Tension measurements as the criterion and it was shown that surface tension can be used as a property for defining broken and unbroken mixtures. A theoretical analysis of shear failure in anisotropic materials was also undertaken and a graphical method of analysis was evolved. A study of compressive strength as a design criterion for bituminous mixtures was made and it was shown that the test could be used as an empirical method of design for bituminised sand mixtures.

Current Research Problems.

1.2.1. Relationship between the binder and aggregate in surface dressing.

Since, at present the quantities of the binders and aggregates used for surface dressing are purely empirical and based only on past experience an attempt is being made to arrive at a quantitative relationship between the binder and aggregates. Different types of binder and aggregates of varying quantities are being used in the investigation.

Based on direct shearing and percentage of unbound aggregates, the test data obtained so far indicate that an optimum relationship does exist between the quantity of binder and aggregates to be used. Further, based on the surface void area measurements, the quantities of different sizes required can also be obtained. It has also been further proposed to lay a series of experimental strips using different qualities and quantities of the binder and the aggregate, on the Delhi-Mathura Road. An interim report has also been circulated. The work is in progress.



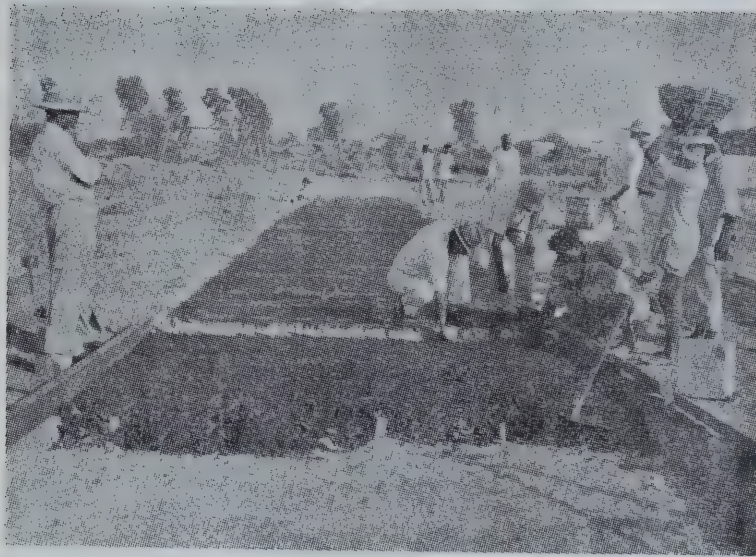
Quantitative relationship between aggregate and binder in surface dressing.

1.2.2. Premix Chippings for surface Treatments:

Since in many States of India, the premix carpet is preferred to two coat surface dressing, laboratory investigations on the same lines as item 1.2.1. have been taken up. Different quantities of aggregate and different percentages of binder are tested for their shear strength. The results obtained so far indicate that an optimum binder percentage is obtainable to provide adequate stability. Two interim reports on this have already been circulated and work is in progress.

1.2.3. Bituminous Stabilisation of Desert Sands:

Due to the lack of good road making materials in certain desert regions of India, only sand has to be relied on. An investigation into the stabilisation of sand using bituminous cutbacks has been undertaken. It was found that addition of 5% of cutback would provide adequate stability under laboratory conditions. The cutback with the harder grade of bitumen was found to give a higher stability value than normal market cutbacks under the same conditions. The results are encouraging. An interim report has already been circulated. Further, on a semifield scale test track different thicknesses of bituminous sand have been laid for testing within the premises of the Institute.



Laying of Sand Asphalt Layer in the Test Track.

1.2.4. Stripping of binders from Aggregates:

Since, one of the failures of a black-top surface is due to lack of adhesion between the binder and the aggregate while in presence of water, the problem of studying the stripping of binders from the aggregates has been taken up. Using Delhi quartzite to begin with, and using different types of binders, the amount of stripping is evaluated. Conditions of testing such as temperature of mixing, duration of immersion in water temperature of water, etc. are all being considered separately.

Based on the results obtained so far an optimum procedure of testing for stripping has been developed, and, various limits such as, Flakiness index, percentage of moisture, Percentage of permissible dust, etc. have also been suggested. It is proposed to extend this investigation to other types of aggregates as well.

1.2.5. Effect of Oxidation on Road Tars:

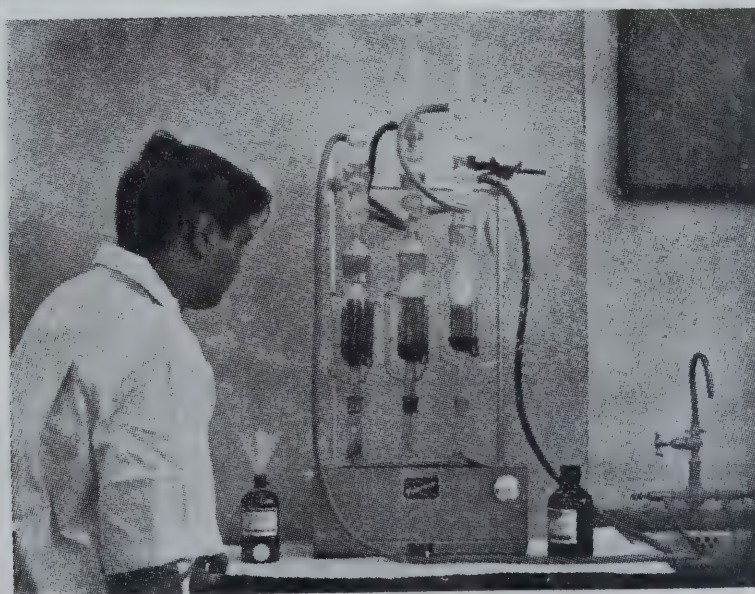
Since the life of a tarred surface is limited by the degree of oxidation to which the tar is subjected, the problem of evaluating the degree of oxidation and its effects on the physical properties are being studied. Frass brittle point, softening point, and viscosity are considered as the criteria for the observance of the changes in tar due to oxidation. The work is in progress.

1.2.6. Absorptiometric Analysis of bitumen:

The phenomenon of light absorption by bitumen solutions has been taken up for the evaluation and identification of different bituminous binders. A two cell photo-electric colorimeter was used, with different concentrations of different bitumen solutions in benzene. The results indicate that the absorptiometric method of analysis could be used to identify different bitumens to a certain extent and also to detect not only weathering but also overheating or burning of the bitumen that has taken place during construction. The results also indicate that the percentage of the two major constituents in asphaltic bitumen can be determined by directly using the individual values of the extinction constants of the bitumen and its constituents. Two papers on this have been submitted for publication.

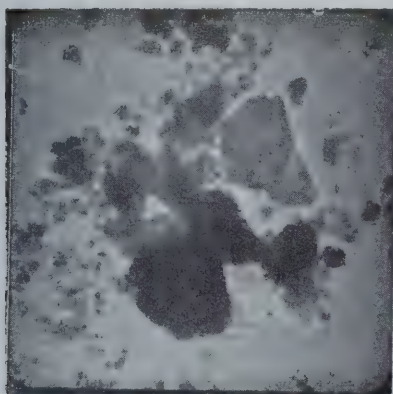
1.2.7. General Investigation:

Failures on black toproads in various regions of India were investigated. Samples from the failed portions were brought to the laboratory and analysed. The causes and possible rectifications of the failures were also suggested. One such case was a few mile stretch on the northern Grand Trunk Road. Extensive cracks have appeared on this road and the causes of these are being studied. A dense bituminous carpet for use on a bridge approach on a main road was also designed after obtaining samples of the materials proposed to be used. It is proposed to circulate the reports among the highway engineers.

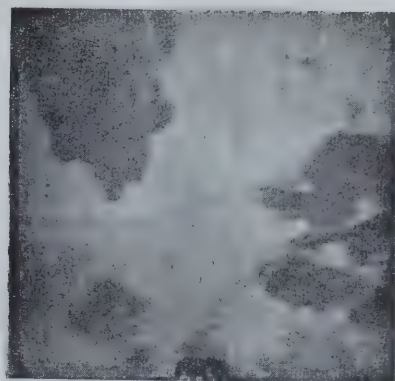


Extraction of binder from road samples.

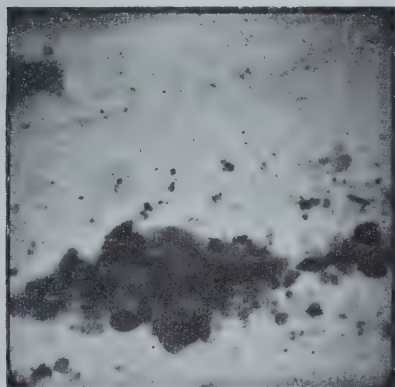
Electron-micrographs for some clays-Magnification 15,000



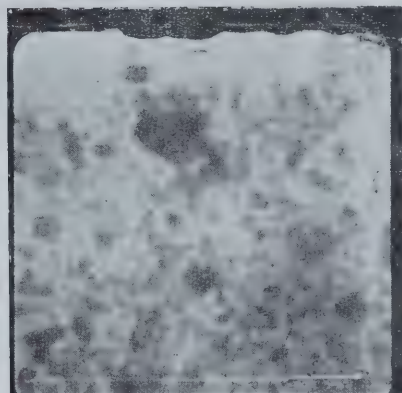
Darjeeling clay. Irregular hexagonal outlines indicate Kaolinite. Cloudy Montmorillonite also present.



Tungabadra clay. Cloudy appearance shows Montmorillonite.



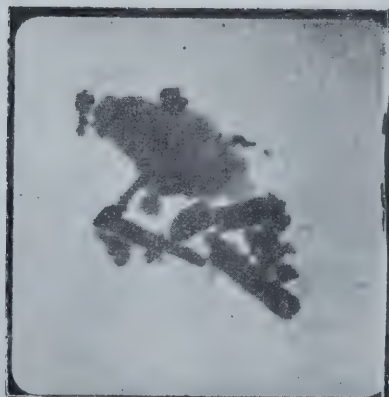
Jumna clay, Hexagonal outlines indicate Kaolinite. Cloudy Montmorillonite also present.



Nagpur clay. Cloudy appearance shows Montmorillonite.



Belgaum clay. Mostly composed of cloudy Montmorillonite.



Talabira shale. Rod-like Mullite is seen in plenty.

1.3. CONCRETE DIVISION.

1.3.1. Investigation on Surkhi as a puzzolana:

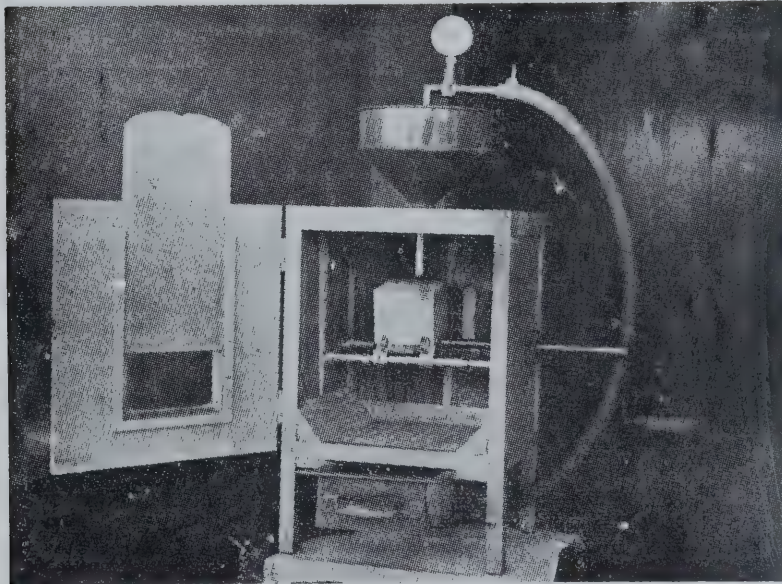
It is known that excellent puzzolana can be manufactured much cheaper than cement by burning certain types of clays (Surkhis) at specific temperatures. The addition of Surkhi to concrete permits reduction in the quantity of cement used without any loss in strength. Besides an actual saving in cement (upto 25%) which could be made possible by using these surkhis, they give to the concrete many other superior qualities such as resistance against chemically corrosive waters, deleterious stone aggregate and chemical salts in soils which progressively cause the deterioration of concrete. The study on the fundamental side has revealed totally new aspects of puzzolanaic reaction, that is, the maximum reactivity of the clay is developed when the mineralogical structure starts breaking. This depends upon the temperature to which these clays are burnt. For Rayerkeri clay this temperature is 600°C and for Delhi clay about 800°C . Also the beneficial effect of some constituents in clay like iron oxide which have not been studied previously has been established. The results of this research can be utilised for starting a new industry for the manufacture of Surkhi and also for inducing the manufacturers of cement to start producing puzzolanic cement in our country, which will ultimately result in achieving great economies in cement concrete construction works.

1.3.2. Development of a method to determine Abrasive Resistance of Concrete.

Absence of a standard method for measuring the abrasive resistance of aggregates and cement mortars in an identical manner has led to the development in this Institute of a pneumatic method of test, which can measure the abrasive resistance of the aggregates, cement mortars as well as the product of their combination concrete under identical conditions. The method was standardised and further improvements incorporated so that a larger area of the specimen could be tested for getting more representative values.

The wearing qualities of some road aggregates used in India as determined by the pneumatic Test are compared with the values obtained from other standard methods of tests namely Los Angeles, Dewals, B.S. crushing, Impact test. The initial results have shown that the pneumatic test will yield more reliable results.

The effect of compressive strength, fineness modulus of sand used for the mortar, lapses in curing, use of various membrane curing compounds, and replacement of cement by Surkhi on the resistance to abrasion of mortars, has been studied:



Abrasion Resistance Cabinet
(fabricated at the C.R.R.I.)

Abrasive Resistance of Concrete Pavements:

The work is under progress with the modified cabinet for establishing the relation of abrasive resistance with flexural strength, compressive strength on mortar sample.

Studies on the effect of gap-grading of sand and the effect of cement replacement by Surkhis of different types on the abrasive resistance of finished mortar has just been taken up.

1.3.3. Alkali Aggregate Reaction:

Certain chemically deleterious materials present in coarse aggregate and sands used in Concrete construction react with the alkalis in the cement giving rise to disruptive expansions which can cause serious damage to concrete construction. The problem is investigated with a view to safeguard against the possibilities of such reactions and suggested methods by which the same could be avoided. On the fundamental side, the complex

process of reaction and limiting conditions governing its incidence in actual practice have been investigated. Use of surkhi as one of the puzzolanic admixtures to counteract the dangers of this reaction is also being studied.

Aggregate Reaction.

Indian made glass is being studied to find out its suitability as reactive aggregate in these investigations so that foreign made pyrex glass aggregate can be dispensed with. Also, further work is being undertaken to find out the probable incidence of this reaction with low-alkali cements.



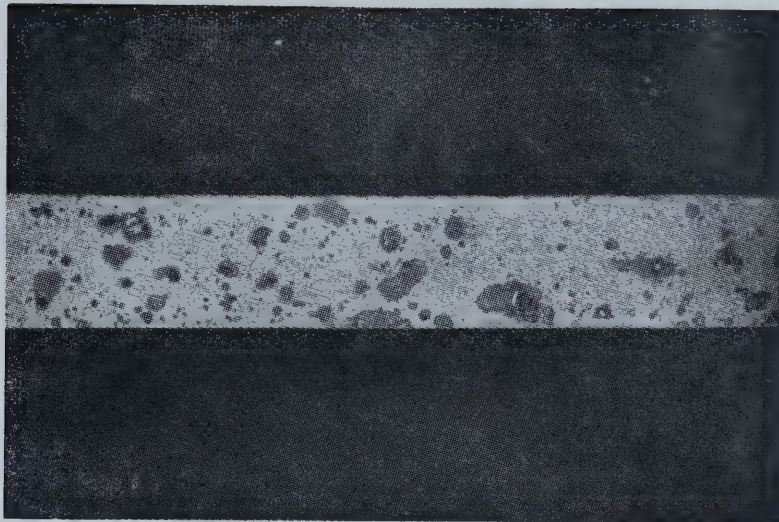
Kashmir Trap(Banihal) showing white reactive silica.



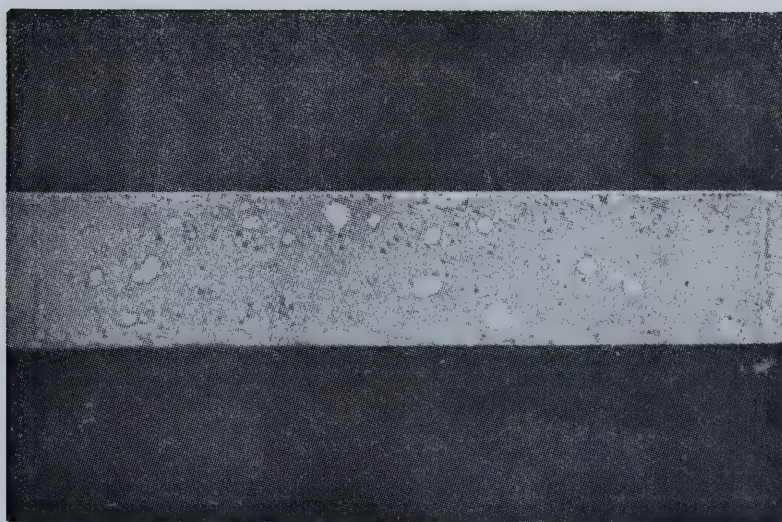
Deccan Trap (Nagpur) showing cavity fittings and veins of reactive silica.



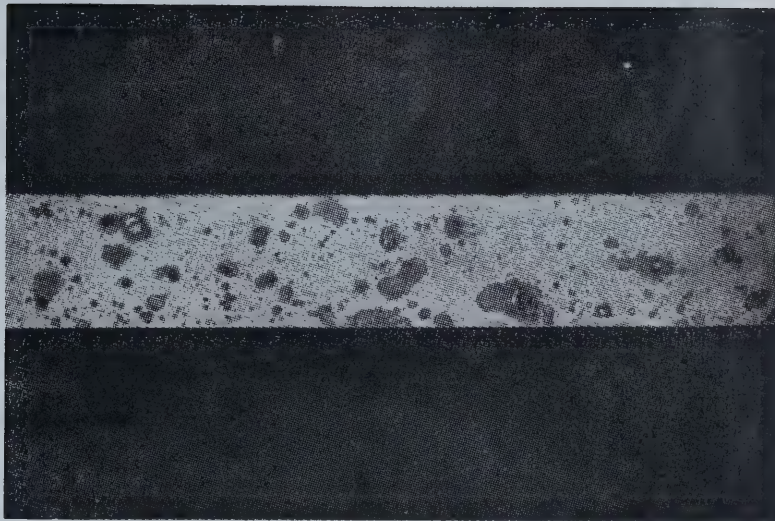
Non-reactive limestone mortarbar free from reactive sports.



Reactive quartzite mortarbar showing reaction spots in wet condition.



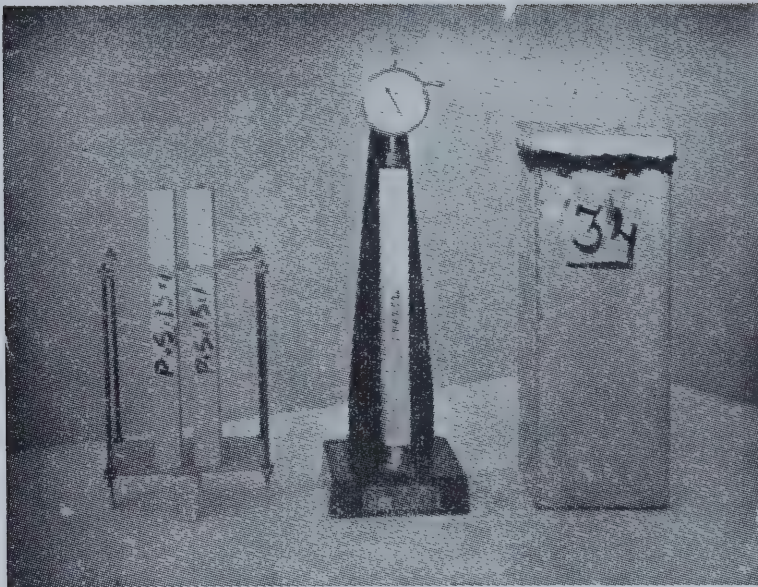
Reactive quartzite mortarbar showing reaction spots dried up.



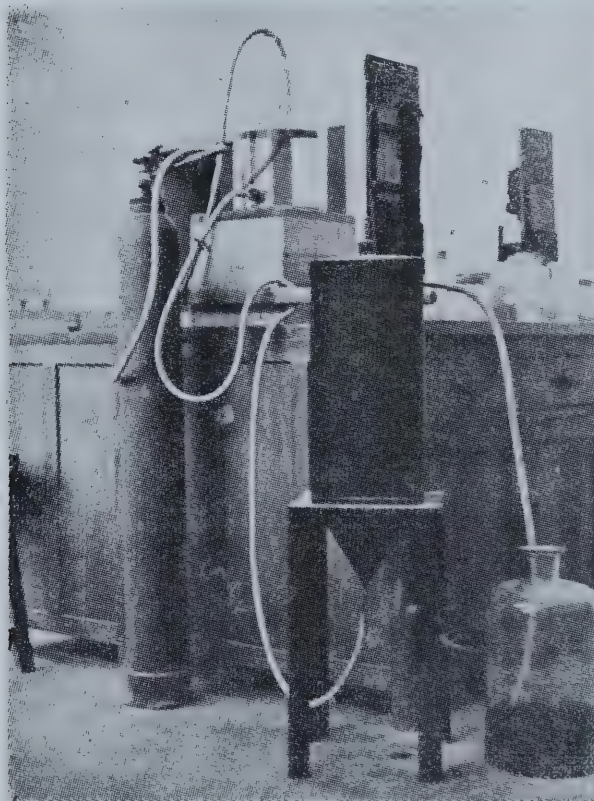
Reactive quartzite mortarbar showing reaction spots in wet condition.



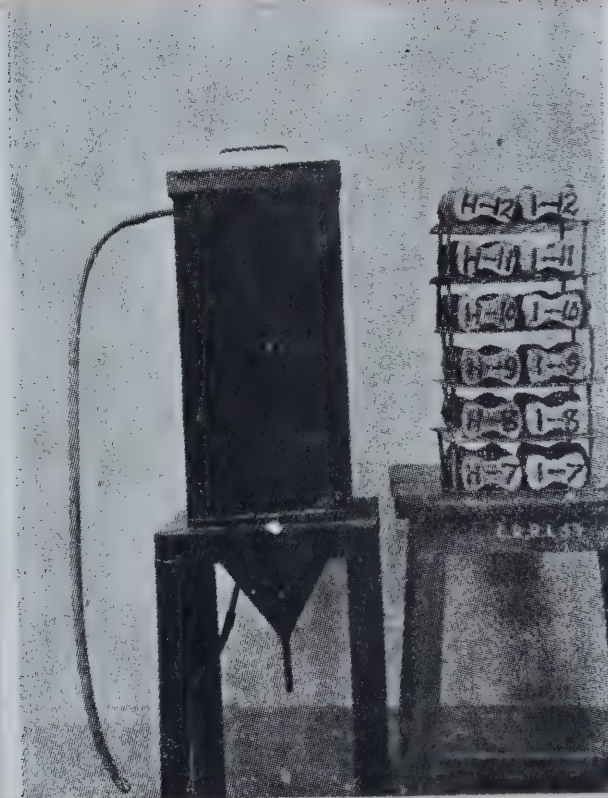
Reactive quartzite mortarbar showing reaction spots dried up.



Comparator and Storage Boxes in Alkali Aggregate Reaction Studies.



Percolator Assembly for leaching of lime.



Percolator with briquettes taken out.

1.3.4. HERL Compactor Adjustment Study.

Various methods of compacting tensile test briquettes for cement were investigated. The investigations disclosed that the HERL Compactor (a mechanical means of compacting tensile briquettes) was the best suited for obtaining uniformity of test results. However, the strength values obtained were far less than those obtained with the briquettes compacted by the B.S. Spatula method. This method is now included in the draft specification of I.S.I. for approval.

Study on Tensile Strength of Cement Mortars using HERL Compactor.

The study is in progress to improve further the method of testing tensile strength of cement mortars using HERL compactor by studying certain factors which will lead to better uniformity and reproducibility of the results.

Determination of mixproportions of Hardened Concrete.

The effect of certain factors like degree of grinding of the sample and the loss on ignition of the sample was studied and suitable recommendations were given. A detailed specification for carrying out the analysis was evolved.

This study has established a more simplified procedure for analysing hardened concrete so that the same could be easily followed by laboratories in the country having only average testing facilities.

1.3.5. Leaching of Lime from Concrete:

Hydration of Portland cement is accompanied by the liberation of free lime which renders the concrete porous, decreases its strength and durability, and causes disfiguration by giving rise to efflorescence. Investigations were carried out to find means of preventing the leaching of lime. Surkhi and ammonium oxalate have been tried for fixing the free lime as soon as it is formed.

1.3.6. Study of membrane curing for concrete:

This problem has a great significance in those areas of the country where due to shortage of water for curing concrete construction is not economically possible. Comparative efficiencies of the various types of solid and liquid membranes such as waterproof papers, plastic films asphalt and wax emulsions etc. for preventing the loss of water through evaporation have been determined. Study on the effects on physical properties of concrete like compressive and tensile strength, modulus of rupture are in progress.

1.3.7. Expansion joint fillers for concrete road slabs:

Investigations carried out for finding out an indigenous material for the manufacture of expansion joint fillers for concrete road slabs at a very low cost indicate that coconut fibre pith which is a waste material in Coir industry can be satisfactorily used in combination with a suitable binder.

Although the filler material satisfied all the basic requirements, efforts are being made to find out a suitable binder compatible with the filler material. Investigations are in progress to improve upon the binder characteristics with a view to obtain a satisfactory product. The binders tried in the investigation have so far given satisfactory results only upto a temperature of 100°F. Attempt is being made to find out other suitable binder which can resist higher temperatures.

1.3.8. Grouted Method of Concrete Road Construction:

This method of concrete road construction is based on grouting the rolled stone metal with cement sand slurry and results in appreciable saving of cement and time, thus lowering the cost of construction of concrete roads. Laboratory investigation on the effect of different mix proportion, fineness modulus of sand, W/C ratio, and addition of workability agents on the flow characteristics of different grouts have been completed and specifications for this method of concrete road construction have been evolved. One mile length of experimental road near Faridabad is proposed to be constructed by this method for comparing its performance with the premix method of concrete road construction.

1.3.9. Relationship between W/C ratio and compressive strength of Concrete made with Indian Cements.

The aim of this investigation is to establish the W/C ratio vs. strength relation, using Indian Cements, which can be used for the design of concrete mixes. A rational method of approach to this study has been laid out and the work is in progress.

1.3.10. Petrographic study of important rock aggregates used for road construction in India.

This study has been taken up with a view to co-relate the important physical characteristics of road aggregates with the help of petrographic study. Physical characteristics of most of the important road aggregates have been determined, petrographic study is in progress.

1.4. ROADS DIVISION.

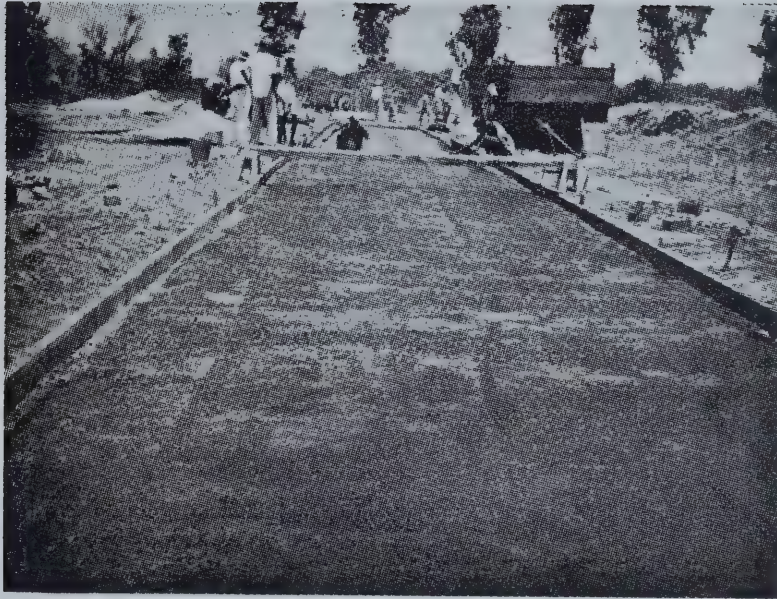
1.4.1. Evolving suitable specifications for cheap all weather roads and field experiments on thin surface treatments.

With the main objective of evolving suitable specifications for cheap all-weather roads, a test track has been constructed to facilitate rapid experimental testing of various specifications under controlled conditions. As a first stage in this programme, work is in progress for testing the effect of types of binder and thickness of surfacing over soil-soft aggregate mixtures and the effect of graft stones in the wearing course of soil or soil-cement or soil-aggregate mixtures, etc., by subjecting these specifications to accelerated traffic both on straight and circular sections of the test track. Another series of experiments is in progress in order to evolve suitable specifications for sandy areas like Rajasthan by finding the optimum thickness of sand asphalt, kankar or a mixture of both, as a wearing surface and as a wearing course. The specifications also include varying thicknesses of surface dressing with premix. The effect of cushioning with sand asphalt between wearing course of kankar and premix in preventing crushing of soft aggregate is also under study.

Full-scale field experiments on thin Bituminous surfacings were carried out on Delhi-Mathura Road and the relative service performance of the following types of surfacings are under observation since the last four years.

1. Asphaltic surface dressings and tar surface dressing.
2. Asphaltic premixes and tar premixes.
3. Surface dressings and premixes.
4. Surface dressings with and without prime cost.
5. Graded and ungraded premixes.

Pending conclusive data this track is still under observation, the normal traffic per day is about 5000 tons.



Test Track work In progress.



Test track work in progress.

1.4.2. Evoving suitable bullock-cart wheel axle systems, with a view to minimise the deterrental effects on highways.

Bullock-cart traffic, an indigenous problem in this country, induces high stresses on the road because of the lack of uniform contact between iron tyres and the road surface as a result of the usual road camber. Various designs for wheel-axle systems are under test in this Institute with a view to evolve a suitable type of self-aligning wheel-axle system for these carts which would help in minimising the destructive effect of this type of transport.



Bullock-cart wheel Testing machine with I.R.C. wheel under test.

1.4.3. Use of low-grade aggregates for road construction in India.

As a first phase of work in the direction of finding the possibility of using locally available low-grade aggregates in roads construction where stone is costly and

scarce, this Institute has taken up the analysis of the chemical and physical properties of laterites and other similar aggregates obtained from different regions in this country and the significance of their properties is being examined in the light of the field performance data of such of those roads constructed with soft aggregates, with a view to give further recommendations regarding the profitable use of this material in different stages of road construction.

1.4.4. Investigations of road failures in water-logged areas.

As detailed investigation on the road conditions for roads around Batala in the Punjab was completed. The investigations include evaluation of the different layers of the road bed and examination of the surface. The failure of these roads was found to be mainly due to the weakening of the subgrade as a result of water-logged conditions which were of recent origin. As a remedial measure it was suggested that a waterproof Bituminous Blanket coat should be given on all sides of the made up subgrade to arrest capillary action. This treatment is being tried out as a field experiment with financial assistance from the Roads Wing of the Ministry of Transport.



Field testing in progress during an investigation of road failure.

1.4.5. Evolving a method of design of flexible pavements for conditions prevalent in India.

In conformity with some special problems, connected with the traffic, soil, and climatic conditions in this country, a plan has been chalked out to conduct an All-India investigation of existing roads both in good and distressed conditions to evaluate them in the light of local conditions and thus arrive at an empirical method of design for flexible pavements.

The scheme envisages large scale field and laboratory testing to evaluate in required detail the various properties of the road materials and subgrade. 21 Master Stations have been selected throughout the country for this detailed survey. Some of the sound and failed portions subjected to heavy traffic on the G.T.Road between Delhi and Karnal were tested and further work is in progress.



Measuring induced stresses in the Road pavements due to static loads.

1.5. TRAFFIC ENGINEERING ECONOMICS
AND STATISTICS DIVISION.

1.5.1. Timing of Traffic Signals for mixed
slow and fast traffic.

It is becoming physically impossible for point duty constables to control traffic at crowded intersections in urban areas. There is a growing need of controlling traffic by automatic traffic signals throughout at intersections in urban areas throughout India. Efficiency of an intersection depends considerably upon the timing plan of automatic signals.

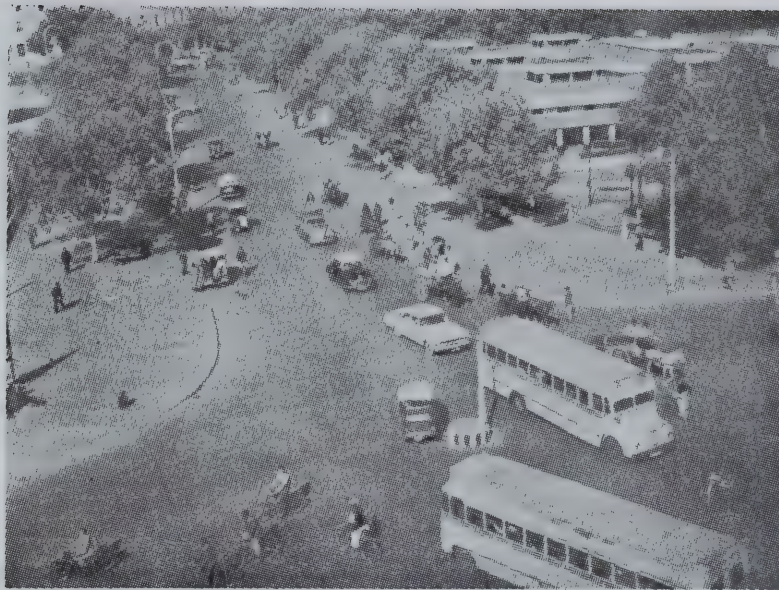
This study was taken up with a view to laydown general specifications for selecting optimum timing under different mixed type of traffic volumes as prevalent in India. Optimum timing plan of signals results in minimum average delay to different types of vehicles passing through an intersection thus resulting in higher efficiency which otherwise is not possible when a point duty constable controls traffic by his personal judgement.

Field study of speed, entrance time and clearing through time for different types of vehicles was made at an intersection. It was observed that one tonga takes as much time as five mechanically propelled vehicles to clear through an intersection. Time required for one bullock cart to clear through an intersection is equivalent to time required by ten or eleven mechanically propelled vehicles. Many other intersecting observations were made and as a result of this study a method has been evolved for selecting optimum timing plan of traffic signals for different traffic volumes of mixed slow and fast traffic as prevalent in India. This is expected to improve efficiency of our urban intersections.

A research paper giving details of the study made and the method evolved is under publication in the Research Bulletin of the Indian Roads Congress '57.



Animals make
road conditions
even worse.



Timing of traffic signals for mixed slow and fast traffic.

1.5.2. Study on Cycle traffic.

Cycle traffic is on rapid increase in urban areas of India. Cycle traffic mixed with mechanically propelled vehicles makes the traffic conditions unsafe. In Delhi, for instance, cyclists constitute about 60% of the total traffic and are involved in over 30% of the road accidents. With a view to reduce the rate of accidents and increase overall efficiency of traffic flow, study on various aspects of cycle traffic has been taken up. Field study of cyclists psychology in relation to road design has been carried out. It has been observed that in summer time more than 40% cyclists go on foot on a 3% uphill grade when the length exceeds 765. ft.. Similar observations for different grades were made with a view to recommend maximum lengths of grades for cycle traffic. Other studies regarding the design requirements of cycle tracks has also been carried out and the research paper concerning the same is under publication.

This study is intended to be extended further for evolving suitable methods of controlling cycle traffic at busy intersections in urban areas. It has been observed that cyclists do not form a line, like other vehicles, while waiting for their 'go' signal at intersections. They form a web through which motorists cannot pass.

This study is expected to result not only in improved safety for cyclists but in overall improved traffic conditions as well.



Study of cycle traffic.

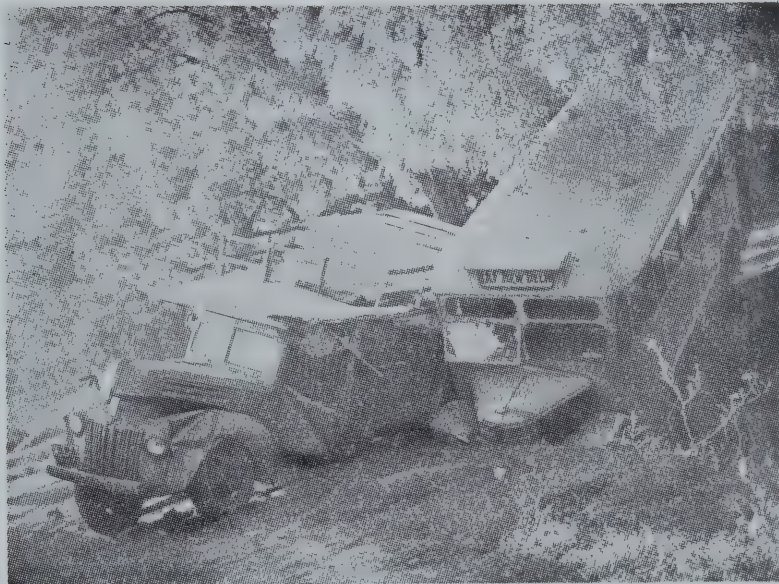
1.5.3. Road accident analysis and scientific investigation.

A study of road accident statistics of Delhi has been made. It has been observed that the total number of road accidents and road traffic fatalities is on/increase. In 1948 there were 281 accidents and 58 fatalities in Delhi as compared to 1179 accidents and 112 fatalities in 1955. At intersections 53% of accidents were amongst motor-vehicles and 28% between mechanically propelled vehicles and cyclist whereas on carriageways the respective figures were 45% and 30%.

It has been further observed that accident recording method of traffic police should be amended from road safety point of view.

So far in India only traffic police have been investigating road traffic accidents. Their view point is mainly to find out the party at fault. Now it has been decided upon the request of the Delhi Road Traffic Advisory Committee that Central Road Research Institute should investigate road traffic accidents in urban area of Delhi to start with. The idea of scientific investigation is

to suggest preventive measures in the way of improved enforcement and road design. Arrangements for starting this investigation have already been made with the Delhi Traffic Police and the Delhi Transport Service.



Accident Study.



Accidents of bullock cart with faster vehicle is becoming more common. Besides material loss to both the parties, the bullock invariably gets hurt or dies.

1.5.4. Study of road users' behaviour.

Study of people for whom roads have to be tailored is important to give consideration to their psychology as far as road use is concerned. Such study helps in adopting road design and other methods for preventing road accidents and increasing traffic flow efficiency. Psychology and behaviour of different types of road users like pedestrians, car drivers, truck drivers, cyclists etc. is being studied. On a particular intersection it was observed that over 64% of pedestrians did not pay attention to traffic signal or cross walks while crossing the intersection. On experimental railing barrier was installed and this decreased the percentage of careless jaywalkers to 19%.



Pedestrians carrying heavy load(hay) or cinema advertisements are a great hazard on roads.

1.5.5. Roadway capacity study:

This study is being carried out with a view to suggest definite geometric design standards for roads for different volumes of mixed traffic. This study not only helps to evolve economical design for new roads but also to improve the existing facilities for present traffic.

A field study was made in urban area of Delhi and it was observed that there is a direct relation between the volume of traffic and its speed. A further study is being carried out to judge the effect of different types of traffic on speed. The study is also being carried out to find the max. volumes of different types of traffic when segregation becomes essential keeping efficiency, safety and economy in view.



Our road traffic problems badly need the scientific approach.

1.5.6. Use of sampling technique in road traffic count.

For proper planning and design of a road, it is necessary to know the average daily traffic flow. To measure the average daily traffic with exact certainty on any section of road would require a continuous count of all the 24 hours of the day throughout the year. This involves a vast amount of labour and cost. To cut down this prohibitive cost, it was considered to be

useful to adopt the Statistical theory of sampling, to obtain a knowledge of the traffic flow by taking counts only for a few days in a year and even for a few hours which would give a fairly accurate estimate of the average daily traffic.

Traffic survey in this connection have been conducted on particular days on two different roads in Delhi. The data have been analysed for the first 3 months. It has been observed that Poisson distribution fits well to the data and the results are promising.

1.5.7. Economics of plastic road markers.

This study has been taken up with a view to find out the availability of practical use and economics of plastic road markers for marking pedestrian crosswalks and center lines of roads in urban areas as compared to other methods of road marking. Plastic markers have been tested in the Institute test track by passing different types of traffic over them. Test track results are encouraging and now it is intended to fix these markers in the field on a busy intersection of Delhi to study their durability and economies as compared to other methods of marking.

2. NEW CONSTRUCTION.

There were no additions to the first stage construction of the Administrative and Technological Blocks of this Institute. Due to want of funds no new construction works were taken up during the year under review.

Construction of (1) the upper storeys of the Administrative Block to accommodate the Traffic Engineering Division, Information, Drawing and Photographic sections and (2) Roads Division, are envisaged during the Second Five Year Plan Period.

3. PILOT SCHEMES:

Three Pilot Schemes for construction of short stretches of stabilised Soil Roads in Madhya Pradesh, Orrisa and Assam costing nearly Rs. 1,00,000/- have been sanctioned. These works are in progress.

4. COMMITTEES, MEETINGS AND SYMPOSIA.

An Executive Council and a Scientific Advisory Committee have been constituted for this Institute. Membership of these committees are enclosed as Appendix III and IV respectively.

The functions of the Executive Council will be to guide the policy and working of the Institute and will mainly be to consider the scientific programme of work, frame the annual budget of the Institute to regulate the expenditure, to consider proposals of projects on the basis of the recommendations of the Scientific Advisory Committee and to make suitable recommendations to the Governing Body of the CSIR: also to determine the strength of staff, take decisions on the creation, suspension and abolition of posts, to appoint scientific and other staff as provided by regulations other than those of Junior Scientific Officers and above, and consider extension of service and imposing penalties of staff as per rules in force.

The functions of the Scientific Advisory Committee will be to advise on the research work in the Institute and to consider and review the budget, to consider and recommend the research programmes, to review the progress of research, consider the annual reports to make financial and other recommendations relevant to the implementation of research projects, to advise on matters of policy relating to patents, publications, pilot plant investigations and processes considered fit to release for industry and National Research Development Corporation, as also to maintain liaison with Universities, Govt. Departments and Industry.

The first meetings of the Scientific Advisory Committee of the Central Road Research Institute was held on the 25th May, 1956 and the First meeting of the Executive Council of the CRRI on the 26th May, 1956.

The Second meeting of the Scientific Advisory Committee and the Executive Council was held on 3rd October, 1956 and 6th October, 1956 respectively.

5. EXHIBITIONS.

1. The Institute participated in the UNESCO Exhibition held in New Delhi in Nov. 1956.

2. The Institute participated in an exhibition organised by the National Physical Laboratory of India at New Delhi during the month of March, 1957.

In both the above exhibitions, items of research work done or in progress in this Institute, and those showing the methods followed for construction of low-cost all weather roads were exhibited.

6. TECHNICAL AID RENDERED TO OTHER ORGANIZATIONS.

(i) Investigations were undertaken in the Punjab State on Sonipat-Gohana Road to find out the causes of road damage and remedial measures were suggested.

(ii) Samples from Patiala-Bhatson Road were tested and the state advised on the construction of the stabilised soil road.

(iii) Load settlement tests were carried out for foundation designed on behalf of the C.P.W.D. and plate bearing tests were carried for the school of Town and Country Planning, Delhi.

(iv) Aggregates from Bhind District -Madhya Pradesh were examined to explore the possibilities of use in road construction.

(v) Different samples of subgrade soils from the black cotton soil area in Bhopal were tested to find out the causes of road failures.

(vi) Samples were tested from the following:

Pipli-Konarak Road, Orissa; Cutch-Bhuj; Ganganagar-Rajasthan and several samples on behalf of the N.B.O.

(vii) Rendered advice on the construction of the Bannihal Tunnel, for the Ministry of Transport.

(viii) Supplied design data for concrete mix for the construction mostly of runways to several Garrison Engineers and some of the State P.W.D.'s.

(ix) Testing work done for many organisations.

- (x) Rajasthan P.W.D.:— investigation on the Bituminous stabilisation of sand.
- (xi) Report on Dadri-Mohindergarh(Ropur) road.
- (xii) Testing work done for PWD's and other organisations.
- (xiii) Investigation of the causes of waviness on Jullundar Road.

This was taken up at the instance of the Roads Wing of the Ministry of the Transport and after field investigations were over, the laying of the concrete road was recommended:

- (xiv) Investigation of road around Batala in Waterlogged conditions.

The causes of some failures which occurred in the roads subject to waterlogged conditions around Batala were studied and the necessary recommendations on the basis thereof were made available.

- (xv) Grand Trunk Road Investigation.

Pursuant to a reference from the Punjab Govt. a detailed investigation was carried out to find out the causes for the deterioration of the surface on some portions of Grand Trunk Road.

- (xvi) Advice rendered to the Delhi Road Traffic Advisory Committee on Traffic Problems.

Traffic volume studies were undertaken at 35 road intersections in Delhi and New Delhi and flow diagrams were prepared for the Town Planning Organisation of D.D.P.A., in connection with the preparation of the Master Plan for Delhi.

- (xvii) For use of soil in engineering construction necessary soil tests are being carried out for the following projects during the last 2-3- years.

- (1) Sind Hydel Project **Srinagar**.
- (2) Chambal Canal Embankment (M.P.)
- (3) Johrat Aerodrome-(E-in-C)
Srinagar -Airfield.
- (4) Building Foundation (C.P.W.D.)
- (5) Bridge construction project across
Gowtami at Ala ~~nia~~.
- (6) Agartala Tripura Access Road (Assam).
- (7) Soil beds for brine solution(Tata Chem.)

7. TECHNICAL TRAINING.

Training facilities were provided to PWD Officers from the States of Behar, Delhi, Bombay, Jammu & Kashmir during the last few years in the technique of stabilized soil road construction.

Training facilities were made available to member of the staff of some Universities and Engineering Colleges in the research divisions of the Institute to undertake short term research problems.

A nominee of the Ceylon Govt. who was deputed to this Institute under the Colombo Plan was given facilities for studying the work of the various research divisions and a short term practical training on some of the scientific investigations in progress.

8. OTHER ACTIVITIES.

Colloquia on Research Problems and Technical subjects were generally held on the last Saturday of every month together with a film show on a technical aspect of road construction, and machinery.

Technical discussions were held with the eminent technical experts who visited this Institute during the year.

CENTRAL ROAD RESEARCH INSTITUTE.

NEW DELHI.

ANNUAL REPORT FOR 1956-57.

APPENDIX I

~~THE~~ FUNCTIONS OF THE CENTRAL ROAD RESEARCH INSTITUTE ANN.

- (1) Fundamental research on the behaviour of materials used for road construction,
- (2) correlation of test results on standard materials with those under practical conditions for enabling reliable estimates to be formed of the behaviour of road materials,
- (3) tests on soils and study of soil mechanics,
- (4) research connected with standards and specifications for roads and road-building plants and machinery,
- (5) design of instruments for road tests,
- (6) studies on road characteristics under different traffic conditions, incidence of accidents, road safety devices and road statistics,
- (7) collaborative research projects with engineering colleges, research institute and industrial concerns,
- (8) technical advice and assistance,
- (9) dissemination of results of research by pamphlets, films, etc., for the benefit of road engineers, and
- (10) training of road technologists.

APPENDIX II.

<u>Sr. No.</u>	<u>Designation.</u>	<u>Name.</u>	<u>No. Of Posts.</u>
1.	Director.	Sh. S.R. Mehra.	1.
2.	Deputy Director.	Dr. R.K.N. Iyengar.	1.
3.	Assistant Director.	Dr. H.L. Uppal.) Dr. Bh. Subharaju.) Sh. C.G. Swaminathan.)	3.
4.	Senior Scientific Officers.	Sh. T.S. Khanna.) " T.K. Natarajan.) " S.A. Swami.)	3.
5.	Administrative Officer.	" Nau Nihal Singh.	1.
6.	Accounts Officer.	" V. Parthasarathy.	1.
7.	Clerk of Works.	" K.B. Batani.	1.
8.	Junior Scientific Officers.	" B.C. Mazumdar) " S. Bagchee.) " K.S. Sankaran.) " Y.C. Gokhale.) " N. Mohan Rao.) " B.N. Sikka.) " Labhu Ram Chadha.)	7.
9.	Senior Scientific Assistants.	" H.S. Bhatia.) " S.R. Bindra.) " R.L. Nanda.) " R. Krishnamchari.) " N.R. Srinivasan.) " T.R. Sehgal.) " M.R. Chatterjee.) " K.P. Nair.) " Ishwar Dayal.) " N.S. Bawa.) " J.N. Malhotra.) " S. Venkataratnam.)	12.

- | | | | | |
|-----|------------------------------|-------------------------|---|-----|
| 10 | Junior Scientific Assistant, | Sh. Gyan Parkash. | } | 6. |
| | | " A.K. Bose. | | |
| | | " Bhupindar Singh. | | |
| | | " K.L. Sethi. | | |
| | | " J.S. Mayall. | | |
| | | " M.S. Rajappa. | | |
| 11. | Senior Lab. Assistant, | Sh. A.L. Chatwal. | } | 14. |
| | | " Oswald Mascarenhas. | | |
| | | " K.P. Banerjee. | | |
| | | " D.P. Sen. | | |
| | | " M.L. Gupta. | | |
| | | " Harjit Singh. | | |
| | | " S.K. Ray. | | |
| | | " Miss. D.V. Hingorani. | | |
| | | " Dalip Singh Dang. | | |
| | | " M.L. Bhatia. | | |
| | | " M.S. Mittal. | | |
| | | " R.S. Shukla. | | |
| | | " R.N. Kapur. | | |
| | | " H.R. Aggarwal. | | |

APPENDIX III.

List of the members of the Scientific Advisory Committees of the Central Road Research Institute.

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|----|---|----------|
| 1. | Sh. S.R. Mera,
Director,
Central Road Research Institute,
<u>New Delhi.</u> | Chairman |
| 2. | Maj. Gen. Aserappa,
E-in-C, Army Headquarters,
Kashmere House,
<u>New Delhi.</u> | Member. |

3. Shri. K.K. Nambier, Member.
Cheif Engineer (Highway),
Chepauk, Madras.
4. Shri. M. Hayath, Member.
Chairman,
Institute of Engineers (India),
Mathura Road,
New Delhi.
5. Dr. K.L. Rao, Member.
Member (D&R),
Central Water & Power Commission,
Bikaner House,
New Delhi.
6. Shri. Govardhan Lal, Member.
Additional Consulting Engineer(R&D),
Roads Wing of the Ministry of Transport,
Jamnagar House,
New Delhi.
7. Shri. J.M. Trehan, Member.
Deputy Standards Officer,
Roads Wing of the Ministry of Transport,
Jamnagar House,
New Delhi.
8. Shri. V.D. Bhandari, Member.
Additional Chief Engineer (Aviation),
C.P.W.D.,
New Delhi.
9. Prof. H. Sunder Rao, Member.
Professor of Civil Engineering,
Indian Institute of Technology,
Khargpur. (West Bengal).
10. Prof. T.S. Venkataraman, Member.
Professor of Civil Engineering,
Engineering College,
Guindy. (Madras).
11. Shri. C.J. Fielder, Member.
Shalimar Tar Products,
Calcutta.

APPENDIX IV.

List of the members of the Executive Council of
the Central Road Research Institute, New Delhi.

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- | | | |
|----|--|----------|
| 1. | The Hon'ble Shri. Jagjivan Ram,
Ministry of Railways,
Government of India,
<u>New Delhi.</u> | Chairman |
| 2. | Shri. H.P. Sinha,
Consulting Engineer (R.D.),
Roads Wing of the Ministry of Transport,
Jamnagar House,
<u>New Delhi.</u> | Member. |
| 3. | Shri. K.K. Nambiar,
Chief Engineer (Highways),
Chepauk,
<u>Madras.</u> | Member. |
| 4. | Shri. R.C. Roy,
Chief Engineer, (Road Development),
Government of West Bengal,
<u>Calcutta.</u> | Member. |
| 5. | Shri. P.L. Verma,
President, (Indian Road Congress),
~~New Delhi~~
Jamnagar House. New Delhi. | Member. |
| 6. | Shri. E.A. Nadirshah,
Chief Engineer,
Concrete Association of India,
121, Queens Road, Fort,
<u>Bombay.</u> | Member. |
| 7. | Shri. W.X. Mascarenhas,
Chief Engineer, (P.W.D.).,
<u>Bombay.</u> | Member. |
| 8. | Shri. D.S. Sinha,
Community Project Officer (I),
Ministry of Community Development,
<u>New Delhi.</u> | Member. |

9. Prof. M.S. Thacker, Member.
Director, General,
Scientific & Industrial Research,
Old Mill Road,
New Delhi.
10. Shri. S.R. Mehra, Member.
Director,
Central Road Research Institute,
New Delhi.
11. Shri. Motilal, Member.
Financial Adviser to C.S.I.R.,
Old Mill Road,
New Delhi.

APPENDIX V.

CENTRAL ROAD RESEARCH INSTITUTE
NEW DELHI.

STATEMENT OF EQUIPMENT RECEIVED UNDER COLOMBO PLAN
UPTO 31.3.57.

<u>Sl.No.</u>	<u>Description.</u>	<u>F.O.B. Cost as per Invoice.</u>	<u>Date of receipt in this Instt.</u>
1.	Lea-Nurse Permeability apparatus (Turbidimeter).	27. 16.2	25.1.57
2.	B.S. Tent Sieves of 18" & 12" dia.	88. 3.3.	27.7.57
3.	Attrition Machine	358. 8.2.	28.6.56 28.6.56.
4.	Aggregate Crushing Test		
5.	Equipment & Accessories.		
5.	Impact Testing Machine and Accessories.		
6.	Rifflers 1" & ½".		
7.	MSE Soil Contrifuge and Accessories.	251. 4.9	21.7.57
8.	6-Test Ring & Ball Apparatus.		28.6.56
9.	Automatic Penetrometer and Accessories.	229. 12.0	28.6.56
10.	Standard Tar Viscometer and Accessories.		28.6.56
11.	Simple Hot Extractor.		28.6.56

12.	Vickers Pyramid Hardness Testing Machine and Access.	429.	7.6	14.8.56.
13.	Acme Air Entrainment Meter.	40.	0.0.	3.7.56.
14.	8" Size 'Cumflow' Concrete Mixer and accessories.	424.	0.0	20.12.56
15.	Photo-elastic Apparatus.	925.	0.0	28.6.56.
16.	G.T. Sand Bath.	14.	1.0	17.12.56
17.	Sykes Vehicle Computer and Accessories.	35.	14.2	9.6.56.
18.	Le Chatellier Water Bath & Moulds.	12.18.0.		25.10.56

Total: £ 2806. 5.0

or Rs. 37543/-/- F.O.B. (U.K.).

APPENDIX VI.

APPARATUS & EQUIPMENT PURCHASED DURING 1956-57.

<u>S.No.</u>	<u>Description.</u>
1.	(a) For Water Measuring Apparatus. (b) Triaxial Compaction Moulds. (c) Dial Indicators. (d) Fixed Ring Consolidometer. (e) Floating Ring Consolidometer. (f) Remindoclock. (g) Consolidation Specimen Trimmer. (h) Jack Assembly.
2.	Hydraulic Ship Jacks.
3.	Spares for Unconfined Compression Tester.
4.	Field C.B.R. Equipment.
5.	Pressure cells and the allied electroic equipment.
6.	Humidity Overn.
7.	Combridge Universal Vibrograph.
8.	Hveem Stabilimeter.
9.	Self Indicating Bench.
10.	Stanton Heavy Duty Balance.
11.	Precision Thelco Oven.
12.	Hot Water Bath.
13.	Water Bath for Soxhelt Extraction.
14.	Gallen Kamp Vapour Density Apparatus.
15.	Beckman PH Meter.
16.	Joint Sawing Machine.
17.	Test Sieves.
18.	Moulds.
19.	Flame Photometer.
20.	Vee Bee Consistomerer.

21. Lever Balance Briquette Machine.
22. Thermohydrogahs.
23. In Situ C.B.R. Apparatus.
24. Road Roller. 8 ton.
25. Self Indicating Counter. 10.Kg.
26. Potentiometer.
27. Stop Watches.
28. Counter scale.

APPENDIX VII.

Library Books and Journals Etc.

(a)	Books	7000	Microfilms	260
(b)	Journals.	220	Maps	68
			Microfilm Reader	
			Microfilming Unit.	

Technical films obtained for the Institute "Highway for Fomorrow".

APPENDIX VIII.

LIST OF PUBLICATION OF THE CENTRAL ROAD RESEARCH INSTITUTE.

Road Research Note No. 1to 8.

1. An examination of Black Top Surface Dresings laid for Field Tests in 1945 on the Bombay Delhi Road.
2. Some observations on Airfield Bunway Surfaced A Bituminous Surfaced Bunway.
A concrete surfaced Bunway.
3. The Compaction of some Alluvial Soils of India.
4. An Investigation on some Leterites.
5. Compaction of Tensile Briquettes in Cement Testing.
6. A suggested Classification of the Black Cotton.
7. A Method for Estimating the Bearing Capacity of Road Crusts with soft Materials.
8. Co-operative Tests on the Expansion of Portland Cements.

Road Research Papers- (Nos: 1to12).

1. Surkhi as a Puzzolana.- N.R. Srinivasan.

CRRI-Ann.Rep-56-57.

2. Shear Failure in Anisotropic Materials.
By C.G. Swaminathan.
Journal of the Indian Roads Congress.
Vol. XIX-2&4, May, June 1955.
pp. 167 to 188-2 & 689 to 693-4, Paper No.174.
3. Laboratory Experiments in Sand Stabilization.
By H.L. Uppal.
Journal of the Indian Roads Congress.
Vol. XIX-2&4, May, 1955. pp. 285 to 300-2.
4. Compressive Strength as a Design Criterion
for Bituminous Mixtures.
By C.G. Swaminathan.
Journal of the Indian Roads Congress.
Vol. No. XX-2&4. pp. 141 to 149-2, paper No. 182.
Nov. 1955.
5. The Importance of Traffic Engineering in India.
By R.K.N. Iyengar.
Journal of the Indian Roads Congress.
Vol. No. XX-3&4. Dec. 1955.
pp. 325 to 357-3. Paper No. 187.
6. 'Resistance to Abrasion of Concrete Pavements'.
By P.J. Jagus and M.R. Chatterje - Journal of
the Indian Roads Congress. Vol. XXI-1,
pages 63-100. Feb. 1957. Paper No. 191.
7. 'Effect of size on compressive strength of soils
blocks'. By H.L. Uppal - Journal of the Indian
Roads Congress. Vol. XXI-1, pp. 129-147, Feb.1957.
8. "Study of soft aggregates from different parts of
India with a view to their use in Low Cost Road
Construction. I-Rajasthan". by H.L. Uppal and
Bupinder Singh - Journal of the Indian Roads
Congress, Vol. XXI-3. pp. 433-457. April 1957.
paper No. 197..
9. 'A study of Accident statistics and some aspects
of Road Users' Behaviour in Delhi'.
By M.S.V. Rao & T.R. Sehgal.
Journal of the Indian Roads Congress. Vol. XXI-3.
pp. 397-416, April, 1957.
10. "Relative compacting efficiencies of vibration
and smooth wheel Rollers".
By Y.C. Gokhale and N.Mohan Rao.
Road Research Bulletin No. 3, - Indian Roads
Congress, New Delhi, New Delhi 1957, pp. 3-26.

11. "Alkali Aggregate Reaction in Concrete Pavements".
By P.J. Jagus and N.S. Bawa. -
Road Research Bulletin No. 3.
Indian Roads Congress, New Delhi 1957.
pp. 41 to 74.
12. "Timing of Traffic Signals for Mixed slow
and fast Traffic".
By Tejbir S. Khanna.
Road Research Bulletin No. 3.
Indian Roads Congress, New Delhi, 1957.
pp. 75-115.

(Nos: 2-12 - separately under publication as Road Research Papers.).

INTERIM REPORTS & OTHER PUBLICATIONS.

Interim Reports.

- | | |
|---------------------------|--|
| No. 1/BD/1
Oct. 1955. | Interim Report on "Quantitative
relationship between binder and
aggregate in black top surfacing
work". |
| No. 2/B.D/2
Oct. 1955. | Interim Report on "Use of Premix
chippings for Tar and Bituminous
surface treatments". |
| No. 3/B.D./3 | Interim Report on "Bituminous
Stabilization of sands in
desert Areas". |
| No. 4/C.D./1
May (56). | Determination of mix proportions
of hardened concrete. |

CRRI-Ann.Rep-56-57. Appendix VIII.

No. 5/C.D./2
May (56).

Leaching of lime from concrete.

No. 6/B.D./3

~~Second Interim Report~~ "Use of
premix chippings for Tar and Bitumi-
nous surface Treatments".

No. 7/C.D./2
August 1956.

Study on Abrasive resistance of
road surfaces.

Other publications.

1. General Report on Road Research India.
Journal of the Indian Roads Congress,
Vol. XXI-3. pages 355-377. April, 1957

CRRI-Ann.Rep-56-57. Appendix VIII.

APPENDIX IX.

A large number of persons visited this Institute during the year under review.

The distinguished visitors included were the following:-
M. S.V. Pumyanzev. Deputy Minister for Higher Education,
U.S.S.R., Moscow.

"Chatokhine Lvas, Engineer, Moscow, USSR.

Rychknov-Alexandre, Delegate from USSR.

Rilippov Bris, Professor, Moscow-Power Institute.

Torocheskmikov Nicolas, Professor, Moscow,

Chernov Eselun, Institute of Foreign Languages, Moscow.

Dr. F.M. Lea, Director, Bldg., Research Station, England.

Robert F Legett., Director, Division of Bldg., Research,
N.R.C., Pttawa, Canada.

Several Members of the Indian Parliament.

Several Members of the Indian Parliament.

U.Maung Maung, Incharge of Physics and Engg. Research Dept.,
Applied Research Institute, Rangoon, Burmah-

Lu Yu-Pei,	Bldg., Research Institute,	Shao Huang Chwang,
		Peking, China.
Chang, Cho,	-do-	-do-

Wu, Lin Shang, Tsing Hwa, University, Peking, China.

E.A. Nadir Shah, Chief Engineer, Concrete Association of India.

A.E. Voss, Coseph Vogele A.G. Mannhein, Germany.

Ulrich Vogele,	-do-	-do-
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R.S. Millard, Road Research Laboratory, Middlesex, U.K.

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